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63C

Calibration

Proc.

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63C INDUCTANCE BRIDGE

CALIBRATION PROCEDURE

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BOONTON ELECTRONICS
CORPORATION

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63C INDUCTANCE BRIDGE CALIBRATION PROCEDURE

The following procedure covers the complete calibration of the bridge. It may be used as a basis for production calibration of new instruments or by anyone repairing or desiring to check any particular section of the instrument.

This procedure may be divided into two main groups:

I. The adjustment of circuits not directly connected with the bridge accuracy but necessary for its proper operation.

II. Adjustment of circuits that are necessary to obtain the basic measuring accuracy of the bridge.

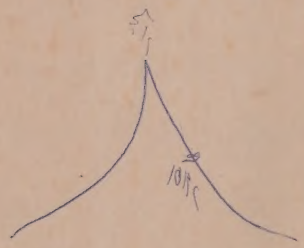
I. 1.0 The first operation of group one would be the calibration of the "Test" oscillator frequency dial. Reference should be made here to schematic 830073 for identification of controls and adjustments. The extreme ends of the frequency range that is 5 and 500 KC should be set to be approximately equal distance from the end of rotation. The changing of the values of resistors R71 and R72 will shift the position of the 500 KC end. Changing the value of C47 will also shift the position of the 500 KC end. The low end (5 KC) may be changed by the value of capacitor C44.

These adjustments will extend or shorten the band width and the values given on the schematic are nominal. To shift the band width, adjust trimmer (C43) in the oscillator compartment. After this is accomplished the dial may be calibrated for all frequencies using an accurate frequency counter or meter. The output voltage level from the oscillator amplifier combination may be measured at J1 and should be approximately 20 to 30 volts rms over the entire frequency range.

I. 2.1 The second operation of group one is the alignment of the tuned detector. This may be done by using a separate oscillator fed into P1. Disconnect coaxial cable P1 and J1. Turn bridge oscillator level to minimum. Connect an oscillator such as a Hewlett Packard 200 CD, (output frequency 5 to 500 KC output level approximately 20 volts rms) to P1. Connect a vacuum tube voltmeter such as a Ballantine 314 at J5. This may be connected in by a "T" connection. Do not disconnect J5 from P5. Set detector range to the low position (5 to 50 KC) and by carefully adjusting controls marked 21 and 24 tune for complete coverage of the frequency range of 5 to 50 KC with no oscillation. Adjustment 24 should be used at 5 KC, and adjust 21 at 50 KC.

C-30 R 56

Bent Reservoir = highest reading on KTKM without fast.



Check the discrimination by setting the oscillator to 5 KC and peaking detector, note Ballantine reading. reset oscillator to 10 KC leaving detector tuning set and again noting reading on the Ballantine. The difference in the two readings in db is the amount of discrimination and should be at least 20 db minimum over the frequency range. The maximum may go as high as 30 db without signs of oscillation but, should never be less than 20 db for good sensitivity of the bridge. Nominal discrimination should be approximately 25 db.

I. 2.2 Repeat the above procedure on the detector range of from 50 to 500 KC using adjustments 23. 22. 25. 19 and 20. Adjustment 22 (RANGE) should be set to bring 50 KC near the counter-clockwise end of R49. Then adjustment 23 (DISC) can be made for the best discrimination. Adjustment 25 (DISC) should be set for the best discrimination at 180 KC, then the low end of 50 KC should be rechecked. Adjustments 19 and 20 are made for the best possible discrimination at 500 KC. After any adjustment is made it is necessary to rotate the tuning control through its entire range and check for points of oscillation. Final adjustment should be made for best discrimination and no oscillation.

I. T[illegible] adjustments referred to above are located in the d[illegible] section adjacent to the oscillator and may be [illegible] by removing the L shield cover, after first removing [illegible] on cover plate.

I. When this operation is completed the detector should [illegible] frequencies from 5 to 500 KC with no signs of [illegible] and a minimum discrimination of 20 db. During [illegible] procedure the signal level used from the external [illegible] ator should be kept as low as possible to obtain [illegible] factory results and not to overload the preamplifier. [illegible] leted the group one adjustments

II [illegible] p two adjustments are all ones affecting the basic [illegible] ng accuracy of the bridge. They should be performed [illegible] This group may be divided into [illegible] ate operations and should be performed in the [illegible]. Refer to schematic 0-0072.

II. 1.0 Ca[illegible]n of the inductance dial, variable capacitor C[illegible] [illegible]stance decade switch S3.

II .0 P[illegible] adj[illegible]

II .0 [illegible] C[illegible].

II. .0 R[illegible] [illegible] R[illegible].

II .0 A[illegible]

II. [illegible] Final calibration with known inductance standards.

II. [illegible] Calibration of The Inductance Dial and Inductance Decade Switch

II. [illegible] The variable inductance dial is an extremely accurate air capacitor, while the decade inductance switch is made up of [illegible] air capacitors in [illegible]. The total inductance dial and each step of the decade switch are in 500 pf steps. Each 100 μh division on the inductance dial represents 50 pf. Their accuracy is of prime importance to the calibration of the inductance measurements.

II. [illegible] Refer to the bridge section schematic 830.072 while doing the following operations.

II. [illegible] Open the circuit at S1 which is the wire braid to the ceramic standoff in the bridge section.

II. [illegible] Open the circuit at B by removing the lead at the transformer (T1) terminal.

II. [illegible] Open the circuit at R2 (1.2K Varistor located below the air capacitor).

II. [illegible] Open the circuit of the R and L zero controls to the air capacitor C1. these are the three leads to the rotor of the air capacitor.

II. [illegible] Set the inductance dial and inductance decade switch to zero.

II. 1.8 Connect a three terminal capacitance bridge with a guaranteed accuracy of ±0.1% at a test frequency of 20 KC, as follows: [illegible] Low point to the bridge section sub-panel. Also connect [illegible] together.

II. 1.9 [illegible] lead length. [illegible]

II. 1.10 [illegible]

II. 1.11 [illegible] inductance switch. Each step is a change of 500 pf and should be within ± 0.1%, if not, adjustments may be made as follows. (Refer to [illegible] adjustments.)

II. 1.12 The 1.000 µh position, the capacity should be 500 pf and may be adjusted by C10.

II. 1.13 The 1.000 µh position, the capacity should be 1.000 pf and may be adjusted by C4.

II. 1.14 The .000 µh position, the capacity should be 1.000 pf

and may be adjusted by C3. On this position the 1.500 pf is the combination of the two capacitors of the first two positions. If an error is indicated on this position read the value of error capacitance then reset the capacitance bridge to zero and then offset it by the amount of error but in the opposite direction. For example, if this position read 4 pf too high, offset the capacitance bridge 3 pf low from the zero position and adjust C3 for a balance. Return the capacitance bridge to zero, rebalance and check the first three positions again. Repeat the above procedure until all three steps are within ± 0.1% of their nominal value.

II. 1.15 The 4,000 μh position, the capacity should be 2,000 pf and may be adjusted by C6.

II. 1.16 The 5,000 μh position, the capacity should be 2,500 pf and may be adjusted by C8.

II. 1.17 Check all remaining positions of the decade inductance switch which should now be within the prescribed tolerance since they are made up of combinations of capacitors all ready adjusted.

II. 1.18 For purposes of adjustment the capacitors are as follows when viewing the inductance switch from the rear.

The right side near the top is C10 then following on a clockwise direction C9, C8 and C7. C3 [illegible] across the switch contacts.

This completes the checking of the inductance decade switch.

11. 1.19 Now check the inductance dial (air capacitor) every 100 μh, which is a change of 50 pf starting from zero, for a total of 500 pf. Errors in the air capacitor can only be corrected by bending the outside slotted rotor plates. This adjustment is extremely critical and great care should be taken, as the final inductance reading will depend on this accuracy.

11. 1.20 Restore all connections to normal except the lead at "B" to transformer T1 which should be left open.

11. .0 Product Arm Adjustment.

.1 The adjustment of the product arm of the bridge is made on a d.c. resistance measurement basis. A resistance bridge accurate to five places is required (0.0000). Three leads are required on the resistance bridge and should all be the same length. Their resistance should be measured and used in the adjustment calculation. One lead should connect the ground side of the resistance bridge to the

ground side of the inductance bridge at "D". The other lead we call "A" should be connected to the [illegible] terminal of the balance capacitor C15, the other lead we shall call "C" will be connected to the [illegible] of the balance capacitor C15. Remove any shorting plug or [illegible]. By referring to schematic 830.072, it will be noted that we can measure the resistance C to D with our lead we previously called "C". Also by reading lead "C" and lead "A" on the resistance bridge we can measure the resistance from A to D. The product of the two resistances that is A to D and C to D is given in the table below.

[illegible]	[illegible]
X10	2×10^7
X1	2×10^6
X0.1	2×10^5
X0.01	2×10^4
X0.001	2×10^3

II. 2.2 Now set the L-R multiply switch to the 0.001 position and measure the resistance from C to D. Subtract from this value the resistance of the leads. Divide 2×10^3 by this value and the result plus the lead resistance will be the amount we must adjust R18 adjustment 1 to. Connecting the

resistance bridge from C to D we adjust R18. to this value.

II. [illegible] Next set the L-R multiply switch to the 0.01 position and measure the resistance from A to D. Divide 2 x 10^4 by this amount to obtain the resistance that will be adjusted to by R20. adjustment 4. and measured from C to D.

II. [illegible] Set the L-R multiply switch to the X0.1 position and measure the resistance from A to D. Divide 2 x 10^5 by this amount to obtain the resistance that will be adjusted to by R21 adjustment 3 and measured from C to D.

II. [illegible] Set the L-R multiply switch to the X1 position and measure the resistance from C to D. Correct for lead resistance and divide 2 x 10^6 by this value. Adjust R22 adjustment four to this value, as measured from A to D.

II. [illegible] Set the L-R multiply switch to the X10 position and measure the resistance from C to D. Correct for lead resistance and divide 2 x 10^7 by this value to obtain the resistance that R24 adjustment five will be set to and measured from A to D.

II. [illegible] This completes the adjustment of the product arm. Several precautions must be taken here to obtain accurate results. The lead resistance must be taken into account on all measurements, especially the low values of resistance.

C to D on the schematic are actually from C through the

II. 4.0 Balance Capacitor Adjustment (C4).

II. 4.1 [illegible] this is a braid lead from the bridge chassis to [illegible] capacitor C1 to the stator section. With the bridge operating at 10 KC (detector tuned) set the L-R multiply [illegible] meter. Adjust for a minimum null which will not be [illegible] terminals must be open.

II. 4.2 Resistance Dial Calibration (R1).

II. 4.1 With the bridge operating at 10 KC (detector tuned), set the L-R multiply switch to the X1.0 position. Connect a decade resistance box (General Radio 1432T) with as short leads as possible to the bridge test terminals. Set all dials of the resistance box to zero. Set oscillator level for approximately one half scale meter deflection. Rotate

resistance dial slowly counter-clockwise, keeping the meter close to a null with the inductance dial. The resistance dial has no stop position and the rotation should be continued until the open position of the control is reached which will be indicated by a sudden drop in the meter deflection. The rotation should be stopped and the resistance zero control adjusted for a null. If this is not done, as the control is rotated through the flat, another dip in the meter reading will be noted. This indication is variable depending on the setting of the zero control. Continue to rotate dial through this flat portion until the deflection starts to rise rapidly. Stop rotation and adjust for a null with the resistance zero control and inductance control. Set the decade resistance box to 0.2 ohms and rotate resistance dial only for a null. Mark the dial at this point as zero. Remove the 0.2 ohms on the decade resistance box and rezero by the resistance zero control. Set inductance zero control at mid rotation. Set the inductance dial to zero and adjust L10 adjustment 12 for a null. Set the decade resistance box to 100 ohms and rotate resistance dial for a null. Mark the dial at this point for 100. Set the inductance dial at minus three divisions (.1) below zero and adjust L9 adjustment 16 for a

dial. The remaining parts of the dial may be marked. After the initial calibration of the resistance dial is made, the marking fiducial should be replaced with the indicating fiducial, with the resistance dial at exactly 100 ohms. If the fiducial is replaced at zero ohms an error of several per cent could be noted at 100 ohms.

II. 4.3 For checking the resistance dial of a bridge that has the dial all ready marked, it is only necessary to verify the dial readings against a known standard decade resistance box.

II. 5.0 Adjustment of Zeroing Controls.

II. 5.1 In the initial calibration of the inductance bridge the ability to zero the bridge at all useable frequencies on all positions of the L-R multiplier switch must be checked. The nominal values of resistors R39, R40, R41 and R42 are chosen that they should require no further adjustment for proper zeroing of the resistance control on the positions of X10, X1 and X0.1 of the L-R multiply switch. However, L9, L10 and L11 which are adjustments 13, 12 and 11 may be adjusted for bringing the inductance zeroing control within its range on these three positions.

II. 5.2 On the X0.01 and X0.001 range resistance wire is used to obtain the proper zeroing adjustment for resistance.

1.5.01

L7 is made up of resistance wire (approximately 0.6 ohm) and the end lead is cut to the proper point for resistance zeroing. The resistance adjustment on the X0.001 range is made up of resistance wire carefully soldered from the "HI" test post to the L and R switch. It is twisted to reduce inductance until the inductance zero falls within range of the zeroing control. These adjustments should be made to insure the bridge can be zeroed on all frequencies and on all positions of the L-R multiply switch. In some cases it may not be possible to null the bridge to zero in that portion of the frequency range which is beyond the recommended settings shown on figure 2 of the Construction book.

II. 5.3 Adjustments of any of the above-mentioned components will not affect the bridge measuring accuracy, if the bridge can be nulled to zero.

II. 6.0 Final Calibration with Known Inductance Standards.

II. 6.1 This is the final calibration of the bridge and requires the most time and care in adjustment. Before attempting the final calibration the bridge should have a minimum warm-up time in its case of at least two hours and if it has been subject to high relative humidity conditions, a 24 hour warm-up time should be given. This final

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calibration requires the use of standards of inductance that have been verified for both inductance and series resistance at frequencies from 5 to 500 KC and several values of inductance. Typical inductances and the frequency requirements are given below for use in calibration of a LC inductance bridge.

Inductance Value	Frequencies for which the Standard Inductance and Resistance Values Must be Known					
1 μH	10KC	100KC	200KC	300KC	400KC	500KC
10 μH	10KC	100KC	200KC	300KC	400KC	500KC
100 μH	10KC	100KC	200KC	300KC	400KC	500KC
1MH	10KC	100KC	200KC	300KC		500KC
10MH	10KC	60KC				
100MH	5KC	20KC				

The above inductances are preferred to be of the General Radio type 1482 which have been verified at the given frequencies. For inductances not available from General Radio modified and standardized Boonton Radio Type 103A "Q" meter coils may be used.

II. C.2 Beginning with the L-R multiply switch on the X10 position and the bridge operating at 5 KC, the accuracy may be checked with the 100 MH and 10 MH inductance standard. If

X10

5KC #5 for 2nd 10MH

Bal Cap.

60KC #17 for 2nd 10MH

(50KC)

10 0555

1 3

cut

5145 1019

25

28.2

24

care was used in the adjustment of the product arm the inductance and series resistance value should be within the prescribed tolerances at this frequency. If not adjustment 5 (R24) may be adjusted for the correct inductance value. The next step would be to check the 10 MH standard at 10 KC. for which adjustment 5 (R24) is also used. It should be set for the closest reading to the standard for both values of inductance at the two frequencies. The next check point would be the 100 MH standard at 20 KC. Here the balance capacitor C15 may be adjusted to give the correct value of series resistance at this frequency. This value should be close to nominal if the balance capacitor was properly adjusted as in step 3. If it is not close to nominal the 10 MH standard should be checked at 60 KC for its series resistance reading which may be adjusted by L-R adjustment 17. This will also have considerable effect on the series resistance reading of the 100 MH standard at 20 KC which should now be rechecked. After alternately checking these two standards the entire set of check points should be carefully rechecked on this setting of the L-R multiply switch. Caution should be observed here in setting the frequency for each check. A frequency counter should be used and the frequency

50 ml

should be within ±0.1% of the frequency for which the standard is verified.

II. . . The inductance of L1 and L2 determine the accuracy of inductance at the higher frequency and the original value of these inductances should be satisfactory if all other adjustments are made as given here. After completing the X10 range, the L-R multiply switch should be set to the X0.01 position.

II. .4 The 100 μh standard should be checked at 10 KC and, if necessary, adjustment 2 (R36) should be made for inductance. Next the 100 μh standard should be checked at 100 KC and adjustment made by 14 (L6) for correct series resistance. Now check the 100 μh standard at 200, 300, 400 and 500 KC. The adjustments at 500 KC are C14 (ON SIDE OF BRIDGE CHASSIS) for correct series resistance reading and C18 adjustment 8 for inductance. After any adjustments to these two the entire range from 100 to 500 KC should be rechecked with the 100 μh standard. It may also be necessary to readjust 14 (L6) to obtain the best results. After these adjustments both the 10 and 100 μh standards should be checked from 10 to 500 KC.

II. .5 The next setting of the L-R multiplier switch is the X0.1 position. A check should be made of the 100 μh and 1 MΩ standards at 10 KC. If necessary, adjustment can be made for

.00 2.5
50
7.5°
2.50

10.29

52.00

162.0

100 to 1000 [illegible]

inductance dial 3 (R31). Next the 100 μh and 1 MH standards can be checked at 100 KC and 15 (L5) can be adjusted for correct series resistance reading. Now check the 1 MH standard from 100 KC to 500 KC. The adjustment made on the previous range (X0.0') of C14 will affect the series resistance reading on this range also, above 100 KC. It may be necessary to readjust C14 on this range and then recheck it on the 0.01 range to obtain the best conditions for series resistance above 100 KC. There is no variable adjustment for inductance at the high frequencies on the X0.1 range. Inductance L1 determines the correct readings and if errors in excess of the bridge specification are noted at the high frequencies, L1 may be changed to compensate for them. An increase of inductance in L1 will cause the bridge to read a lower value and so a decrease in it value will cause the bridge to read higher.
After all adjustments are made the 100 μh and 1 MH standard should be checked from 10 KC to 500 KC. Also if C14 has been adjusted on this range it will be necessary to recheck the X0.01 range.

11. 6.. The next position of the L-R multiplier switch is the X1.0 position. The 1 MH and 10 MH standards can be checked at 10 KC and adjustment made by 4 (R22) for correct

inductance reading.

The 10 MH standard can be checked at 60 KC and the 1 MH at 100 KC. and adjustment 16 (L4) can be set for correct series resistance reading.

II. 6.7 Next the L-R multiply switch should be set to the X0.001 position. The 1 μh and 10 μh standards should be checked at 10 KC. Adjustment may be made for inductance by 1 (R18). The 10 μh standard should be checked from 100 to 500 KC and adjustment ϕ (13) made for series resistance. Adjustment 7 (C19) adjusts for correct inductance at 500 KC. Some 63C bridges contain an additional adjustment 9 (C20) depending on the type of resistor used for R37. In bridges containing C20, it should be used for series resistance adjustment at 500 KC in addition to 6 (C13).

When all adjustments have been made the 1 μh and 10 μh should be rechecked from 10 KC to 500 KC. It will be noted that C19 will have an effect on the series resistance readings on this range also at frequencies above 100 KC. However, if the X0.01 and X0.1 ranges have been properly adjusted, C13 adjustment 6 (and 9 (C20) in bridges containing it) should be adequate for series

resistance readings above 100 KC.

II. 6.0 This completes the calibration with the standards for inductance and series resistance. A complete run through the readings for all standards should be made again at this time to insure that proper adjustment has been made. At all times care should be used in moving resistors and leads on the L-R multiply switch which can effect readings at the higher frequencies.

II. 7.0 During this calibration the frequency at which the inductances have been standardized at, must be maintained within 0.1%. Also the standards must be connected to the bridge with uniform and short connections in order not to introduce errors. If standards of inductance and series resistance are not available for these frequencies, an attempt to calibrate the bridge should not be made.

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